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ABSTRACT

Australia has tended to lag behind the nations leading the field of technology in using its scientific and technological resources. To link technology more closely with industry and economic growth, the Australian government has taken many initiatives in recent years. The new technologies are having an impact on societies and the individuals within those societies in three ways: economic impact and unemployment, impact on the quality of life, and emotional and intellectual impact. In general, Australians have ambivalent attitudes toward science and technology. Conflict between their rational and emotional responses is evident. For many, feelings of resistance to new technologies are deeply felt and mostly negative. The use of technology is affected by extremes of choice, alternative futures, and extent of trust in decisionmakers. The basis for making choices is informed debate. Recent developments in technical and vocational (T&V) education in Australia have focused on courses about the social implications of technology. No research has been done concerning the impact of technology courses on the perceptions, beliefs, attitudes, and personalities of students in the T&V sector. This deficiency must be corrected if recommendations for action are to be made. The T&V education sector has a future role in promoting a use of technology which adequately takes account of individual human beings and their needs. (Appendixes include a list of 59 references and student performance objectives.) (YLB)

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# STUDIES IN TECHNICAL AND VOCATIONAL EDUCATION

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AUSTRALIA

# Development of Technical and Vocational Education in the Humanistic Spirit

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28. Organization of Productive Work in Technical and Vocational Education in Kenya (1985, English).



*(continued on inside of back cover)*

# Study on the developments of technical and vocational education in a humanistic spirit: The situation in Australia

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# PREFACE

The present document is a further addition to the series "Studies in Technical and Vocational Education". These studies are based on a Unesco policy instrument, the Revised Recommendation concerning Technical and Vocational Education, which was adopted by the General Conference at its eighteenth session in November 1974. Furthermore, they are in conformity with the Approved Programmes and Budget which envisaged the production of guides, studies and other publications in the field of technical and vocational education. The studies are intended to assist policy-makers, planners, administrators and experts in technical and vocational education. They reflect Unesco's concern with fostering an effective exchange of experiences and ideas in this field as well as Member States' efforts in promoting the implementation of the Revised Recommendation and the Convention on Technical and Vocational Education and the development and expansion in this field of education.

The studies, which have been prepared under contract for Unesco should be considered as information documents that would assist national authorities and specialists in technical and vocational education. A list of the studies is on the inside of the cover of this document.

We wish to express our appreciation to the author(s) who have prepared this study and hope that it will provide its readers with information useful to them in the promotion and development of technical and vocational education.

The views expressed in this study are those of the author(s) and do not necessarily reflect those of Unesco. The designations employed and the presentation of the material do not imply the expression of any opinion whatsoever on the part of the Unesco Secretariat concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

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# Study on the developments of technical and vocational education in a humanistic spirit: The situation in Australia

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## INTRODUCTION

This paper is concerned with the impact of technological development on society and individuals and with the role of technical and vocational (T&V) education in ensuring that the technologies are used to meet human needs in a 'humanistic spirit'.

It is clear that ideas from technology and the products which derive from those ideas continue to transform the world in which we live. They have an obvious impact on our economic life by generating wealth as well as affecting the way in which individuals live their lives.

Technological development is seen by many as a process out of control and as a dehumanizing force in society. Accordingly there is concern that it may already be reducing the sense of self-worth and purpose in life for many individuals.

In response to this growing concern many countries are seeking ways to ensure that the moral and political consensus of their peoples guides the future uses of technology in ways which promote humane ends. It will be shown that many

thinkers see technology as having the potential to make individuals feel more human rather than less human.

The analysis begins with a review of the developments themselves with a particular emphasis on the initiatives and developments in Australia (Section1). This is followed by a consideration of the various ways in which the technologies may change societies and the individuals within them (Section 2). Section 3 draws some conclusions about the beliefs and perceptions of australian citizens in the face of technological change. Section 4 highlights the choices facing humanity in the face of technological development and stresses the role of informed debate. Section 5 introduces some recent developments in T&V education in Australia and focusses on courses about the social implications of technology. Section 6 is concerned with the way in which technology may affect the personality, beliefs and personalities of students in T&V education and recommendations for future investigation are made. In Section 7 a series of recommendations is made concerning the future role of the T&V education sector in promoting a use of technology which adeqately takes account of individual human beings and their needs.

In this paper it is assumed that the often predicted onslaught of technology on humanity is not inevitable and that societies can choose how they will use the technology. It is also accepted that the education sector can and must make a significant contribution to allay the pessimism by providing information about the technology and the implications of different choices about its use.

The spirit of concern about the future was expressed eloquently by a young australian child in the words:

*"The nuclear holocaust has come and gone. Technological civilization has survived. But the myth of goodness isn't there".*

Education owes it to the next generation to do its best to ensure that human 'goodness' is not lost as a consequence of decisions about how to use the new technologies.

## SECTION 1. NEW TECHNOLOGICAL DEVELOPMENTS

### An overview

Technological developments with obvious economic and social impact have become so diverse and complex that it would not be possible in a paper of this kind to provide a comprehensive review. Worldwide there has been an explosion of activity in the past few years.

Extensive research and development continues to improve the speed, power and memory capacity of computing devices of all kinds. Leading the way is the work on parallel processing machines, linking many processors and thus enabling them to process volumes of data simultaneously. Work on improved data storage has progressed to the point that 100-billion bit optical disks can be expected in the near future.

Alongside the development of hardware has been extensive work on software to take advantage of the new architectures. Work on the so-called 'Fifth Generation' artificial intelligence project, in Japan, is probably the best known endeavour of this kind.

In the near future, one can confidently expect the emergence of the syntax-free use of computers as well as human speech input to the machines.

Work also continues on an ever increasing range of technologies including semiconductor technologies, sensor technologies (e.g. biosensors, chemical sensors and transducers), optoelectronics, human computer interface technologies (e.g. computer graphics, synthetic speech and speech recognition devices), computer-aided design, intelligent robotics and industrial process control technologies, integrated software, very large-scale integration (VLSI) of microelectronic circuits, computer-aided decision-making and project management, and so forth. The range is becoming so extensive that it is difficult to capture all developments in summary form.

These technologies are making significant changes to human life as they find application in a diverse range of human endeavours, including defence (e.g. the 'smart' weapons of the U.S. Strategic Defence Initiative), transport, health care (e.g. medical scanners and computer-assisted diagnosis), weather forecasting and environmental monitoring, robot mass production, hydroponics, ocean- and space-based industries, education, integrated automated office systems, database management as well as the entertainment industries.

Nowhere has the impact been more obvious in recent years than in the sphere of communications. Dramatic developments have taken place as a result of the combined use of computer networks and satellite technologies. Rapid communications across the world are now possible in ways which were hardly conceivable a few years ago. The use of bulletin boards, electronic mail, tele-conferencing, video phones, interactive videotex and Fax machines are radically altering the way businesses and institutions conduct their daily affairs. Widespread research into and development of all kinds of network services software and systems will ensure that the range of possibilities continues to grow.

Many citizens who have had little contact to date with computer technology will undoubtedly purchase some of the new products which are emerging as a result of combining technological developments from different areas. For example, the pairing of a microcomputer with a CD-ROM player opens possibilities for "interactive multi-media". Alternatively, a computer can be built in as part of a home compact disc player. Many people who may not consider buying a home computer will nevertheless obtain one by default when they purchase a CD player for a sound and video system. The same will happen with the introduction of high-definition big-screen television sets (HDTV) which also function as computers.

Such combinations will permit access to a multi-media universal library; information will be obtainable from a variety of sources through a network. Many more homes will have access to a variety of electronic information magazines, news reports, journal abstracts, digitized pictures. The possibilities for interactive education software distributed through a network or sold on compact discs are enormous. The gradual merging of the computer industries with the

broadcast, movie, print and publishing industries will result in increasing numbers of citizens having access to information by using a variety of new techniques.

**Artificial Intelligence (AI)**

Underlying the range of technologies and their applications is a growing theme of increased 'intelligence' exhibited by the machines. While AI began as a separate movement outside the mainstream of information science, it has now progressed to the point where its ideas and applications are beginning to dominate every sphere of technological advancement.

Much has been written and continues to be written about the impact (real and potential) of non-AI technology. Recent developments in AI intensify these expected effects and open up qualitatively different ones as well.
Because of the progress made in chip design AI techniques can now be applied to an increasing range of tasks with greatly increased levels of performance. At the same time AI techniques are generating new industries (e.g. computer sensing) and creating new professions such as knowledge engineering.

The discussion about the future impacts of technology has now largely become one of making predictions about the effects of applying increasing levels of computer intelligence to all areas of human activity.

The application of increased levels of machine intelligence will obviously have a dramatic impact on the economy. However, in keeping with the theme of this paper, there are other impacts, of a more personal kind, for individual citizens.

Computers, particularly with increased levels of intelligence, have the capacity to enter into the mental and emotional lives of individuals.

In human terms the major impact of AI research may prove to be the influence it has on the psychological and intellectual climates of a society. It will be shown later in this paper that it is already changing the way some humans see themselves.

Machine intelligence is assuming the key role in a consideration of the human spirit in relation to technological development. For this reason and for the purpose of subsequent argument in this paper, the nature of AI is briefly summarized and three critical areas of enquiry are described, viz. expert systems, natural language systems and artificial vision.

## The nature of artificial intelligence

There is no agreed definition of AI. However, according to Trappl (1985) the multitude of definitions tends to fall into three main categories. There are those who attempt to program computers to perform in an intelligent manner, called the 'behaviour-oriented' approach. The computers are able to do things that, if done by humans, one would say that intelligence was required. Game playing programs are the prime examples. Researchers in this group are mainly concerned that the program is able to perform the required behaviour, they are not particularly interested in determining whether it carries out the tasks in the same way as humans.

Other approaches to AI try to model human thought processes in order to understand the human mind better, called the 'cognitive approach'.

A third type of approach is not only concerned with producing software, but also with building machines, called the 'robotic approach'.

The different approaches tend to be associated with different research programs and products, although any particular project may fall under more than one approach.

### Expert systems

There are many products from AI which are beginning to have an impact on society and which can be expected to become more sophisticated in the future. For example, expert systems are computer programs that make available to the user the knowledge and expertise of experts in a particular field.

A typical expert system has a set of production rules for interpreting knowledge in a field, it has an initial set of facts and relations which can be extended, it can carry out a dialogue with the user and do plausible reasoning as well as explain its decision-making. A well-known example is MYCIN which can make hypotheses about a patient's illness (Shortliffe, 1976) and it can perform as well as an expert diagnostician. There are other expert systems for fields as diverse as chemistry, molecular genetics, electronics and law.

Current systems tend to be inflexible and restricted to very narrow domains of knowledge. They are relatively unsophisticated, e.g. they cannot perform non-

monotonic reasoning. That means that once a proposition has been proved true or false a system cannot change that decision in the light of subsequent information as human beings commonly do. Likewise an expert system program cannot adjust its explanations to account for the knowledge and style of learning of an individual learner. Although some progress is being made in the problem of representation of the users knowledge base. For example, the BUGGY program of Brown and Burton (1988) provides a diagnostic model for funding 'bugs' in the mathematical skills of children.

The development of programs with more sophisticated and more human characteristics will no doubt require higher levels of understanding human psychological processes. Programs will need to reflect the complex mental organization and inferential processes of human minds.

One of the great hopes for many researchers in the field of AI is that it will provide insights into the nature of thinking and even of human creativity.

Expert systems are now often seen as the basis for the field known as knowledge engineering.

### Natural language systems

Natural language systems are designed to understand, process and generate language used by humans as distinct from the usual programming languages used by computers. Such systems are employed in machine translation from one human language to another as well as in understanding and processing information from texts including text analysis. They are also used for generating

text and natural language interfaces in expert systems, database systems and other applications requiring question-answer facilities. Natural language systems are seen as an important part of the wider enterprise of improving human-machine interactions. Systems are in development which will eventually be able to perform input and output in natural human speech.

AI techniques will undoubtedly make it easier for users to communicate with computers. Computers will communicate more effectively with people and eventually understand the intentions of the user and adapt to individual styles.

### Artificial vision or artificial sensing

One other major area of AI development is in artificial vision. This includes hardware and software to perform tasks such as picture processing. It has special application in remote sensing, particularly with satellite support; it is used in surveys of natural resources, crop characteristics in agriculture, meteorology and so on. It is beginning to be used in areas such as medical radiology requiring sophisticated analysis and processing of complex images.

AI techniques are involved in providing robots with vision for object recognition and discrimination in terms of characteristics such as colour, texture, shade, edges, regions, 2D and 3D properties, and so on. Robotic vision is also used for tasks such as range finding and tracking objects in motion. One interesting application is being built into programs for producing robotic systems that can milk cows. Machine-vision techniques are being examined to track the motion of a cow's body in real time when it comes close to a milking mechanism. The

tracking has to be completed with great precision so that a robot arm can attach cups to the cow's teats without causing damage.

Machine-vision techniques are also being used in a variety of situations requiring inspection, selection, evaluation, assembly and transfer of operations. In the UK, for example, machine-vision is being incorporated into a robotic system to inspect and grade potatoes, carrots, green beans and tomatoes. The systems will also be able to detect surface blemishes on the vegetables and the presence of any non-vegetable material on the conveyor.

In view of present research and development it is now more appropriate to refer to robot 'sensing' rather than robot vision. In addition to seeing, robots are being designed to hear, smell, taste, feel and move. As a consequence, robots are becoming more autonomous in their movements and are being equipped with a range of senses greatly increasing their effectiveness and flexibility.

## Technology in Australia

After a brief review of some of the developments on a global scale, attention now turns to the situation in Australia.

At the outset, it must be acknowledged that Australia has tended to lag behind the nations leading in the field of technology in utilizing its scientific and technological resources. Within the country it is often stated that Australia's industrial capability in science and technology is amongst the poorest in the industrialized world.

Currently Australia is suffering serious economic problems with a large deficit in its balance of payments combined with abnormally high domestic interest rates. It is felt by many that the underdevelopment of science and technology may in part be an explanation of the economic ills.

It is clear that, in the past, leaders in business, industry and politics have placed too little emphasis on technological ideas. Surveys conducted in Australia have shown a general lack of knowledge among Australian senior executives about technological developments.

One comparative study (PA Technology, 1985) indicated that Australian executives were disorganized in their approach to keeping informed about technological developments when compared with their counterparts in other developed countries. The study also revealed that Australian business executives tended to regard research and development as a *"reluctant (sic!) tactical necessity"* rather than an essential feature of an overall strategic plan.

In a similar vein, other studies have shown low levels of knowledge among Australian leaders about scientific and technological developments. The changing Australian survey (Social Science Data Archives, 1983) and the survey of senior executives (PA Technology, 1985) are typical examples which demostrate this pattern.

There have been several examples where good Australian ideas have not been exploited within Australia; in some cases the development, production and associated economic gain occurred outside the country (e.g. the "black box" flight

recorder). The acceptance of an idea as a resource in its own right, as a source of employment and as a means for generation of wealth has not been as readily appreciated in Australia as in the economically leading countries.

There are important signs indicating that the country is undergoing a change in approach.

In order to link technology more closely with industry and economic growth, many initiatives have been taken by the Australian Government in recent years.

### Partnerships for Development Program

In September 1987 the Australian Government announced its Information Industries Strategy in order to exploit the potential of the industry within the country and to take advantage of the possibilities which international co-operation could generate.

The Partnerships for Development Program is the cornerstone of the Information Industries Strategy and seeks to foster collaboration between local firms and transnational organizations. It is designed to establish development of Australian ideas and to form marketing links with the world market. Participating companies are committed to certain levels of expenditure on research and development in Australia (five per cent of total turnover in Australia) and to achieving specified levels for local content in exports (50% export-import ratio, with an average local value added of 70%, or value added exports equal to 20% of total turnover).



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In return the companies become exempt from offsets requirements from Commonwealth and participating State Civil Offsets Programs. The Government also agrees to assist the industries by providing a supportive infrastructure and to participate in publicity promotion. Australia also provides an ideal base for the export of products and services to customers in the Asia/Pacific region.

Already an impressive boost has been given to Australian industry through partnership agreements with many companies including IBM, Apple, Cincom, Digital Equipment Corporation (DEC), Hewlett-Packard, Honeywell Bull, Unisys, Nixdorf, ICL, NEC and Wang.

For example, DEC has established an Australian Technology Centre in Sydney which has already produced a high-performance communications controller designed and developed in Australia. The product is to be distributed by Digital worldwide. The Centre is also intended to become the company's focus for expertise in Wide Area Network communication products.
DEC is involved with education and training programs for the Pacific Basin area. They are working with the NSW Department of Technical and Further Education (TAFE) in developing computer-based training programs for delivery via satellite.

DEC is also working on another project aimed at year 11 and 12 students. It involves the production of interactive video programs giving detailed information and advice about careers in the information technology industry. These and other proposed initiatives by DEC involve cooperation and joint ventures with many Australian public and private sector organizations.

The other multinational companies involved in the Partnership Program are making similar contributions to Australian industry. Projects undertaken by the companies to meet Partnership targets cover the complete range of industry activities.

Currently the products include knowledge-based "tool kits" for commercial applications; plastics technology products; network management systems for use in the banking, insurance and manufacturing industries; advanced Electronic Funds Transfer Point of Sale (EFTPOS) equipment; computer safeguard equipment; multi-tasking communications equipment; equipment to demonstrate the practical and commercial value of computer recognition of natural speech; image processing for the mining industry; a Weather Satellite Ground Station product.

In all, the commitments by the transnational companies involve annual investments of $A246 million in R&D and exports of $A1087 million by 1994 (Department of Industry, Technology and Commerce, 1988).
Many of the companies are developing and diversifying their education, training and service activities with a view to marketing them in the Asian Pacific Region.

### The Grants for Industry Research and Development (GIRD) Scheme

Beginning in 1985, the Australian Government introduced a series of measures to encourage companies incorporated in Australia to undertake R&D in Australia.

Compared with other OECD countries private sector spend[illegible]?&D had been very low, while the Australian Government's expenditure had been comparable with the others. The Australian Government therefore introduced a 150% taxation concession scheme in an attempt to lift the contribution made b[illegible] private enterprise.

In 1986 the GIRD Scheme was introduced to complement the taxation concession initiative. Under the scheme, grants are given to help applicants exploit project results for the benefit of the Australian economy (Industry Research and Development Board., 1987, 1988, 1989).

The Department of Industry, Technology and Commerce (DITAC) has also designated four areas as generic technologies of fundamental significance for industry competitiveness in the 1990s. In each of the areas of new materials technology, biotechnology, information technology and communications technology, grants may be made by the Industry, Research and Development (IR&D) Board for pre-competitive strategic research. These grants are given for projects which would be unlikely to develop if left to market forces alone.

One of the major objectives of the generic technology grants is to foster joint investigation between tertiary institutions and/or research organizations and commercial interests. Within the information technology area, support is being given to work in software engineering, person-machine interaction, information management, computer networking and device and system hardware technologies.

Other policies to change the attitudes of Australian industry have included tariff reform, the National Industry Extension Service and the Teaching Companies Scheme.

Overall the collection of initiatives is designed to improve technological awareness in industry, to lift the level of R&D undertaken by industry and to improve links between industry researchers and research institutions.

### The Science and Technology Statement

The approach by the Government is not without its detractors. There are those who do not deny that scientific enquiry should contribute to economic development, but feel it is best achieved through increased funding to public sector institutions.

Others feel that the approach undervalues the role of pure research and fails to acknowledge the unpredicted applications of theoretical enquiry. The history of scientific enquiry is full of instances where seemingly purely theoretical research ends up helping most unlikely industries and solving practical problems which could not have been predicted before the research was begun. This makes it difficult to know exactly where to put limited funds in order to give the maximum economic return.

Governments need to ensure that they do not put all their resources behind projects which seem to promise specific returns at the expense of more basic research. The patterns of the past suggest that governments should also continue

to support imaginative pure research in order to maximize the serendipity factor, that is the possibility of significant results arising from unplanned sequences.

The problem facing any modern society is how best to form a balance between long-term basic research and short-term research aimed at solving specific problems for specific industries.

Interestingly, the definition of R&D for the purpose of the GIRD scheme specifies the objective in terms of *" new knowledge (with or without a specific practical application) or new or improved materials, products, devices, processes or services"* (Industry Research and Development Board brochure, 1988). Despite the acknowledgement given to research 'without a practical outcome' it is felt by some that, in practice, too much emphasis has been placed upon R&D which holds out a promise of short-term economic gain.

In May 1989 the Prime Minister and the Minister for Science (who is also the Minister Assisting the Prime Minister for Science and Technology) issued a statement entitled "Science and Technology For Australia" in which they explore the distinction between 'fundamental'(or basic) and 'applied' research.

In the statement it is proposed that such distinctions are not very helpful and the labels 'long-term research' and 'short-term research' are introduced as being more appropriate in times of rapid advances in scientific and technological enquiry. In the conclusion of the report it is stated that *"government policy will increasingly emphasize the need for high-quality long-term research to provide new ideas and foster a strong core capacity to underpin new developing technologies"* ( Hawke & Jones, 1989, p.31).

The report restates the Government's strategic approach to strengthening the nation's base of science and technology and forming closer links with industry in order to improve the economy. In addition, it announces new measures designed in response to concerns expressed by the scientific community in Australia. In addition to highlighting its commitment to long-term or basic research the Government has decided to give a $A390 million boost to public sector funding over a five-year period.

It has extended its 150% R&D tax incentive scheme for private sector research and development until 30 June 1993 (it was originally intended to run until June 1991). The change is estimated to cost $A640 million in lost revenue. The statement also proposed 2% of GDP as an appropriate level of funding for R&D, a figure which will require further increases in both sectors.

In addition more funds are to be allocated to expand the higher education system with growth directed towards priority areas such as engineering, computing, business and management studies. In order to ensure an increase in the number of skilled and innovative researchers the number of postgraduate and research scholarships is to be dramatically increased.

In order to coordinate Government policy more efficiently and provide a national forum for the discussion of scientific and technological issues, a Prime Minister's Science Council is to be established with wide representation within government, scientific and industrial circles.

At a later stage in the paper we will discuss another initiative by the Australian government to link futures planning with government and commercial initiatives, namely the Commission for the Future.

**Communications**

If there is one field in modern technology where Australia already competes strongly by world standards, it is in communications, especially those involving satellites. Perhaps it is Australia's vastness and small population combined with the long distances to the world business centres that has fired organizations such as TELECOM and Overseas Telecommunications Corporation (OTC) to focus resources for research and development on communications. Australia is at present a world leader in at least two areas of application, Integrated Services Digital Network (ISDN) and very small aperture terminal communications (VSAT), and is poised to take advantage of its expertise.

*Integrated Services Digital Network (ISDN)*

This is a computerized digital telecommunications service providing high-quality and reliable voice, data, and image transmission. It normally offers access to existing services such as telephone, data transmission, fascimile transmission and leased circuits.

TELECOM and its partners have ensured that Australia has a lead in the field. According to BIS-Mackintosh, a British independent research company which monitors telecommunications developments worldwide, *"Australia is the crucible. It is now the most advanced country in the world in the development*

*of ISDN"* (Gordon,M, 1989). BIS Mackintosh estimates that there is a 12 month window of opportunity for Australian industry to exploit its lead and develop a range of new products and services.

*Very small aperture terminal communications (VSAT)*

Australia, through OTC Australia, is a world leader in the use of very small aperture terminal communications (VSAT). In 1989, OTC became the first organization in the world to offer international two-way data communication using their VSAT service called Satnet. The arrangement allows a personal computer or data terminal to be hooked up to a small satellite dish at the point where the service is required, while at the other end a computer is linked to an earth station in Australia enabling them to communicate by satellite.

The facility enables private communications to be made directly to customers' premises without using existing telecommunications services; it means that databases of large corporations can be made immediately available to local branches anywhere and at any time. Direct and accurate communication can be made with the highest levels of security. The user has the advantage of not having to queue or suffer slow response times when the normal public communication systems become congested.

To date OTC has tested the system in Antarctica, Sri Lanka, India and Sweden. All network monitoring and control facilities for Satnet are managed within Australia itself.



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**Robots and automation in Australia**

As in the United States, Australia has recently suffered poor sales of robots, especially for industrial applications. In May 1989 DITAC held a one-day workshop on robotics and automation. It was reported that the Australian manufacturing sector was too small to sustain a local industry producing robots solely for domestic use. Despite considerable government assistance in the form of grants and bounty payments ($A1.4 million in 1988) Australia's leading manufacturer of conventional robots, Machine Dynamics, is now in receivership.

The workshop concluded that there is great scope for Australia to develop robotic systems for use in non-traditional applications such as agriculture, mining, construction and the service industry. At present the agricultural, construction and mining industries rely on imported machinery.

Delegates at the May workshop saw the lack of specific government policy on automation as a major obstacle in development. While it has been declared a "sunrise" industry and thus worthy of special promotion and support, there are no specific strategies or programs in place and it is was not included in the list for generic technology grants.

The growing interest in the use of robotics outside traditional manufacturing is exemplified by current Australian research into robotic sheep shearing.

Also in 1989 Australia held its first seminar on robotics for food processing and agriculture. The seminar reviewed the present application of robot and machine-vision technology to inspecting, sorting, grading, cutting, packing, picking and

manipulating agricultural and food products. It was sponsored by the Queensland Departments of Industry Development and Primary Industries and by the Council of Australian Food Technology Association.

Increasingly, Australian robot manufacturers will be turning their attention away from applications for assembly lines and factories and focus more on solving particular local problems.

## SECTION 2: THE IMPACT OF THE TECHNOLOGY ON HUMAN BEINGS

We have identified three main ways in which the new technologies are having an impact on societies and the individuals within those societies. The first is the most obvious and concerns the economic impact including the implications for employment. According to many authors the impact is so significant that it is causing an economic revolution based on 'information' as the new commodity. The second impact is concerned with the ways in which the technology may affect the way people live their lives, gain satisfaction from their activities and feel they make a worthwhile contribution to society. Thirdly, there is evidence that for some people, at least, the technology has important philosophical and psychological significance. The second and third kinds of impact are of great importance in terms of the way individuals perceive themselves and the extent to which technological developments may or may not have 'humanizing' effects.

In this section the three kinds of impact are treated in order, beginning with economic considerations with particular reference to unemployment.

## Economic impact and unemployment

### The post-industrial revolution

According to the current Australian Minister for Science the developed world is in the midst of a 'post-industrial' revolution (Jones, 1982). We are witnessing change in which the manufacturing sector is no longer the main employer of people.

According to many analysts it is 'information' which is fast becoming the new commodity in defining the economy. Other writers, instead, speak of the knowledge industry (Rubin, Hubin & Taylor, 1986). Many authors see an emerging 'information society' as fast becoming a replacement for an older industrial one.

Worldwide there appears to be a shift from resource-based to information- based industry. In factories, a few people using technology are able to produce more nowadays than in the past. Likewise in the agricultural and resources sectors similar changes are taking place; everywhere technology is making it possible for more to be achieved with fewer people.

The emergence of 'information' or 'knowledge' as an economic commodity raises some important issues concerning employment and viable economies which will be explored at a later stage in this paper.

The technological developments described to this point are obviously having dramatic effects on the economies of the world, but the exact nature of their impact is not so clear. The relationship between technological progress, employment and the generation of wealth has not been delineated in any commonly accepted manner.

While much is written about the 'information' or 'post-industrial' economy there is no agreement about its nature, viability or desirability.

It is not always clear what is meant by 'information' or what professions to include in the new society of workers. Often the term is given a wide interpretation indeed, so that the list of occupations of those working in the information industry would not only include information scientists and technologists, but also teachers and lawyers. By this account, information workers are seen to be all of those who are employed in producing, collecting, processing, managing and distributing information in one form or another.

Given this wide interpretation it can be shown that in developed countries the total number of those working in the information industry is greater than the total of all those employed in mining, manufacturing, construction, farming , and so forth. In short, more capital is being invested per employee in offices than in factories and farms.

At other times 'information' as an economic commodity is not seen so broadly, but is restricted in use to refer to new ideas in technology and to computer software. By this account, information workers (or workers in the knowledge industry) are those who acquire work by developing and applying the ideas

(Rubin, Hubin & Taylor, 1986). The use of the term information is here more closely linked to its use in the field of IT. Rumberger and Levin (1985) refer to workers in the 'high-tech' industry.

Even within the more restricted interpretation one can distinguish between the IT ideas and the products which result from those ideas. In some countries (including Australia) there is still a tendency to think of work in terms of that which results in the production of goods. In the field of IT, the economic components are 'things', such as computers and satellites rather than the ideas which make them possible. In the industrially leading countries ideas are more readily seen as commodities in new economic structures. Australia by contrast has tended to keep those who produce ideas away from the economic mainstream (Ellyard, 1989)

Instead of making a distinction between manufacturing and information, others prefer to contrast manufacturing with 'service' (Quinn, Barach & Paquette, 1987; Cohen &Zysman, 1987). Thus there is a definitional overlap between the information sector and the service sector; those involved with professions such as education and law may be placed in either category. So a particular individual, such as a teacher or a lawyer, is regarded as a worker in the information industry in one study and as belonging to the service sector in another.

### Employment trends

Many of the reported studies draw conclusions and make predictions based on what has happened in the past 15 or 20 years. There seems to be a basic difficulty with this process as the nature of technological development does not lend itself

to extrapolation. No one predicted the invention of the microchip or its impact. Studies of past trends are dealing with earlier computer technologies and have no way of taking into account the possibilities for the more intelligent machines under development. It would seem that one is dealing with an area in which it is hard to do much more than express an opinion.

It is often difficult to draw conclusions from the literature on technological development and employment trends because of differences in defining the various employment subgroups. Nevertheless it is possible to detect some general points of agreement.

Many of the studies from the United States seem to agree that relatively few jobs will be created within the high-tech sector itself (Birch, 1987); it is predicted to reach only 4% of the non-agricultural workforce by 1995 (Levin & Rumberger, 1983).

There seems to be agreement that the greatest job losses have come from the traditional manufacturing sector (Daniel, 1987). Even in countries where the actual number of people employed in manufacturing could increase, it is certain that the proportion of the total labour force in this sector will drop. Large-scale industry can never be expected to employ the vast numbers of workers of the past, unless there is a substantial change to the nature of that employment, for example the time spent at work.

The decline in numbers employed in manufacturing has seen a corresponding increase in the service sector. There is strong disagreement about the possible long-term economic consequences of this trend.

According to Quinn et al (1987), many service industries are beginning to look like manufacturing industries with centralized, large-scale and capital intensive facilities with standardized output and automated distribution techniques. Service sector salaries are increasing relative to other sectors and more services are being exported. They predict that most of the opportunities for growth will arise in services in the future. They feel that a service dominated economy could support real increases in income and wealth for a long time. By this account business and government should not waste money trying to prop up manufacturing industries that have in the past employed large numbers.

By contrast, others feel that this trend should not continue indefinitely because the service sector should not grow without a strong industrial base. For example, Cohen & Zysman (1987) argue that higher paid manufacturing jobs are needed to support many lower paid service jobs. They point out that manufacturing in the United States has maintained its share of the GNP (but not employment) over the previous 40 years. They bring into question the wisdom of a society accepting 'deindustrialization' at all; to do so could result in critical damage to an economy. Their argument is predicated upon the assumption that manufactured products are more tradeable than services. If their analysis is correct then a country would seek to move to a post-industrial economy at its peril.

### Significance of assumptions about nature of wealth

It may be that such disputes are really concerned with assumptions about the nature of wealth, the ultimate source of wealth, the nature of employment and the relationship between wealth and employment. Does wealth reside in

property, resources (minerals, food, etc), goods, money, possession of information or ideas, power over others, or is it arbitrary? Can wealth be generated without natural resources or manufactured goods? Can ideas only become a source of wealth when there is a source of resources or goods to support the appropriate economic structures? Does a conception of wealth include employment? Does an increase in wealth presuppose that more jobs will be created? Does employment only refer to payment for services? Do we have to suppose that the present forms of income distribution will remain in place?

Differing assumptions can lead to differing conclusions about the viability of the information society and the impact of technological change on employment.

For example, if the production of more jobs is seen as an important component in the generation of wealth, then it will have to be included as a separate objective in making decisions about the use of technology. No one doubts that investment in technological based industry can promise improved productivity and high levels of capital return (especially with the new generation of intelligent machines). It is also true that this can be achieved with a decrease in the need to employ people. If the sole objective is improved productivity then job creation will not be automatic.

### 'Jobless' growth spreading to non-manufacturing sectors

These same trends may soon apply to non-manufacturing sectors as well. It remains to be seen whether continued growth in the service sector will result in a proportionate increase in the number of jobs. The same technologies that have been transforming the manufacturing sector are starting to be applied in the

service sector. It has already been mentioned that many robot manufacturers are turning away from assembly lines and factories. Applications are being found in fast-food, hospitals, commercial cleaning, support for the aged and infirm. Robots are also being developed that can serve as nurse's aides in hospitals or help the physically handicapped.

As intelligent computer technology begins to penetrate the service sector on a large scale it will put pressure on job creation opportunities. The technology has the potential to cause the "jobless growth" of manufacturing to spread to all sectors of employment.

Unlike earlier technologies the use of increased computer intelligence can effect massive changes in the "white-collar" field. Expert systems and automatic planning and managerial systems will be able to perform many white-collar tasks with little human involvement. The same kind of redundancies may come to the office as have been seen in factories. Much of the so-called information industry could become automated. Already predictions are being made about great reductions among clerical workers in businesses such as banks and insurance companies. It will even effect managerial functions involving decision making, reporting, fact-gathering, supervision of subordinates and so on.

In professions such as education, law and medicine the impacts can be expected to be just as dramatic. In education, for example, the role of teachers could dramatically change. The load for lesson preparation and correction of student work could be greatly reduced when sophisticated intelligent computer assisted instruction begins to make its impact.

**Employment- several options**

In a free economy it seems inevitable that business will make decisions to automate because of the reduced costs and the raised quality of the goods and services. For many businesses the main way of increasing short term profitability and competitiveness will be to reduce costs for personnel and this will increasingly be achieved by computerization.

As with industry, it seems that employment can only be guaranteed if it is built in as a specific objective. If wealth generation is seen only as increased profits to share holders, jobs will certainly not be ensured.

Many writers have proposed alternative ways of distributing income to citizens which are not based on a traditional concept of employment. It is often proposed that the increase in wealth due to automation and computerization can be redistributed enabling individuals to participate in other means of making making money such as stock market investment. It is usually suggested that a transition period is needed in which workers can be gradually replaced and be involved in job sharing, reduced number of working hours and income compensation schemes.

Proposals for such solutions are not new; Kelso and Adler (1958) described a society in which machines produce all the necessary goods and each citizen is a minor capitalist with income derived from dividends on common stock.

It is often assumed that people are powerless in the face of the changes being triggered by technological development; for many there is a feeling of

inevitability about future directions. However it is worth remembering that human beings are the ones who make the decisions about how technology is used. Just because technology can be used to create wealth with little human involvement it does not mean that societies must use it in that way.

In the case of decisions about employment, the decision makers will either have to ensure that employment is deliberately built into plans to use technology, or they will have to find new ways of distributing money. Failure to act could have severe social consequences. If alternatives to traditional employment patterns are sought, it will be necessary to ensure that people can gain satisfaction from their activities and have a sense of making worthwhile contributions to society. This consideration leads us to the next theme as the discussion turns to the needs of human beings in the face of technological progress.

**Impact on the quality of life**

To this point we have considered the economic impact of the new technologies. The effects on the needs and aspirations of people, on the way people want to live their lives have largely been ignored. Humans have featured to the extent which they may be involved as consumers and as workers in new economic frameworks.

Presumably most people would agree that technological applications are only important because human beings are important. It is hard to imagine technology being used in a situation if human beings were not to benefit in some way. Of course it may be the case that some may benefit at the expense of others.

Democratic countries, at least, face the difficult task of fitting human needs and aspirations into their formulas for economic progress.

Many governments have long been aware of the economic consequences of technological development but only recently is there evidence of them trying to build into their formal policies a concern for human values and needs. For example, in Australia, the recent Statement on Science and Technology acknowledges that science and technology are fundamental to *"concern for human values and culture"* (Hawke & Jones, 1989, p.1). Finding mechanisms for ensuring that the use of technology has a humanizing rather than a dehumanizing one is a massive challenge for any society.

Already there are signs that many people have fears about technology reducing their quality of life and their significance as individuals. Concerns have long been raised about the impact of computer technology on employment (quantity and quality), privacy, individual freedom, leisure, centralization of political power and so forth. The concerns become more acute with the introduction of more intelligent machines.

Quality of employment

Often the quality of working conditions are largely ignored when plans are made to introduce technology into the workplace. Too often the human aspects are overlooked. Rarely are the motives of people for working taken into account.

It is clear that people do not work solely for the financial gain. Many seek personally valuable benefits from their jobs; they hope for a sense of

achievement and purpose while acquiring personal satisfaction from their efforts. For many it is the main avenue for self-definition, so that when they become unemployed there may be a sense of loss of self-worth. For others, work can also create opportunities for growth and learning and provide the main outlet for social interactions. If working conditions are changed so that the opportunities for people to meet their needs is reduced there may be a loss of harmony in the workplace. Even if the objective of meeting human needs is not accepted for its own sake, it would appear to make sense in terms of work efficiency.

There is a growing realization that there are human factors and quality of work factors which can play significant roles in determining the success or otherwise of any workplace. In particular, with the introduction of new technology and the associated changes in work flow and work roles, it is even more important to manage the human resources effectively.

If the point of introducing technology is to improve the competitiveness and performance of an organization it often fails. The technology, rather than boosting performance, actually disrupts work systems and causes increased alienation among the workforce. There is evidence that computers often increase the stress levels of employees, add to fatigue and boredom and contribute to feelings of depersonalization.

In the United Kingdom, a Department of Education and Science (DES) report indicated that stress was greatest in offices which had the greatest contact with technology (Cox, 1986). Stress comes about when workers are inadequately trained to use the new technology and have to cope with the changes. Garson (1988) argues that computer technology is changing the office into a highly

stressed version of a factory from the past. It is a common theme in management studies that stress has a very damaging impact on job performance (Boddy & Buchanan ,1986).

Likewise, in factories (e.g. General Motors), it has been found that difficulties can occur with automation if insufficient account is taken of human needs in planning for a smooth operation in production. It seems that in both offices and factories successful computerization is not as simple as exchanging a computer for a worker or group of workers.

Certain kinds of interactions with computers can depersonalize the users and result in a sense of anonymity which could lead to a lack of respect for the system. It may even result in a diminished sense of ethical and moral responsibility in workers. Computerized monitoring of individual performance in offices is an extreme example of a depersonalizing use of technology. Studies indicate that it tends to promote a particular type of bureaucratic behaviour typified as, 'if an activity is not being monitored it is not worth doing'.

If humans are required to perform only highly repetitive functions with the machines, then high levels of fatigue and boredom can only be expected to result. Similarly people who are forced to put blind trust in the technology must be expected to lose a sense of personal autonomy and feel that their capacities for decision making are undervalued. The combination of an increased dependence on technology and a lack of understanding of that technology can only increase a feeling of personal incompetence.


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These problems have, of course, been found with relatively unsophisticated computers. As autonomous and multi-sensing machines are incorporated into operations, new problems with man/machine interactions and human needs will no doubt surface. As described earlier, it could mean massive levels of unemployment, at least as we understand that term at present.

It can be expected that many areas of employment will remain relatively resistant to technological takeover. Areas such as the caring professions, day care, many aspects of health care, human counselling of all kinds, psychoanalysis, sport, entertainment, arts and crafts will provide human employment for the foreseeable future.

It is often suggested that, in the future, people will be employed for those skills which are peculiarly human. As machines become more 'intelligent' greater emphasis will be placed on human qualities such as originality, creativity, intuition, inspiration, understanding of others, leadership, humour and friendship.

It may be worth emphasising that the major potential impact of technology on people is to increase the range of choices they can make. It follows that one of our most fundamental responses to technological change is to find ways of increasing peoples capacity to make good choices. This proposition has obvious implications for education and these are explored in the final Section.

**Leisure**

The intensive use of intelligent computer systems could mean that people will become less dependent on other humans for obtaining many of the things that satisfy their needs. Since the work place is the main source of socialization for many people it will be important to ensure that home life does not become socially isolating for the new 'unemployed'. Enforced leisure has the potential to cause many people to see life as pointless and to see themselves as social parasites.

Unless people were to undergo a massive shift in perspective towards work and find alternative and socially acceptable means for self-expression great social disquiet and public unrest can be expected.

For many authors the scenario provides a setting which is almost utopian. They speak of the "new unemployment" as a liberating development, allowing people to spend more time on activities that are more satisfying and humane than most jobs at present. Margaret Boden (1983) argues that AI driven automation has the potential to be 'rehumanizing' than 'dehumanizing'. She sees it as a means for not only freeing human beings from drudgery but for humanity. It will lead to a re-discovery of quality human interaction as people will have the time to develop friendships and enjoy each other in ways which have been lost. People will have much more time to pursue intellectual and cultural pursuits.

The problem with a society becoming more intellectual and cultural is that not everyone is intellectual or cultural. Activities would have to be found to ensure that all people felt they could make a worthwhile contribution to society.

If any of these predictions were to materialize it is obvious that the education sector would have to sprearhead the new orientation. There would be a need to bring about a change in perception about work, at the same time as moving away from the model of one period of training to acquire sufficient knowledge and skills to last for life. There is obvious scope for adult education in arts, crafts, literature, writing, sports and so on, so that people would be able to benefit from their increased leisure.

### Privacy and freedom

Participatory democracy requires individuals who see themselves as responsible, relatively autonomous and free. Many see the emerging technologies as being helpful in increasing democracy and increasing individual freedoms. Giving people access to vast amounts of information from their homes is an example of increasing individual autonomy and freedom.

On the other hand, the same technology could be used to deny citizens access to all kinds of information. The scope for the powerful to use technology as a tool to ensure uniformity in behaviour and to manipulate people is enormous.

Already many fears are expressed about databases kept on citizens by governments and business interests. Concerns are frequently expressed about possible inaccuracies in the information, the keeping of more personal information than is necessary, illegal access and use of information and the exchange of information between agencies. Many personal accounts indicate that the level of misuse is higher than might be wished.

The new generation of technological tools, with huge databases combined with machine intelligence and satellite communications, could easily combine to form an efficient police state.

New technologies are producing extraordinarily sophisticated and powerful means for collecting data about, and monitoring the behaviour of, individual citizens. It is possible to use computer systems to intercept and analyze telephone, telex, data and radio transmissions of all kinds. At the most sophisticated level the United States Defence Advanced Research Projects Agency (DARPA) is involved in the development of a program using artificial intelligence and parallel processing techniques to help detect drug-related criminal activities.

The potential of such systems for the invasion of the privacy of individuals and the covert control of their lives is enormous. How can a state balance its role of preserving law and order and its own security against the rights of citizens to basic freedoms?

**The emotional and intellectual impact of technology**

**The second nature of computers**

On the surface a computer is an object for analyzing data, but behind this facade there lies another object which has the power to reflect our emotions and to provoke us to think philosophically. Turkle (1984) describes this evocative object as the 'second nature' of a computer.

Usually when we think about the impact of computers on society we consider their first nature; that is, we study computers as tools for processing data. The study of technology and its impact, to this point, has really been about the first nature of computers. To complete the analysis of their impact on the human spirit we will have to focus also on their second nature.

Those who interact intensively with the machines or who are involved with computer research are the people most likely to feel the impact of the second nature. They are the ones who describe how the new machines affect their emotions and change the way they think of themselves.

Many of these people report that their interactions with the machines have a positive influence upon their lives and their self perceptions. They see that developments in machine intelligence have a significant humanizing potential which needs to be promoted in the community in order to offset the commonly held view that computer theories presents a threat to humane conceptions of humanity.

**Influence on philosophical and psychological theories**

The ideas from computer science particularly from AI research are having significant impacts on psychological and philosophical thinking. Computer modelling and brain modelling research are providing insights into human thinking.

In psychology, AI research is at the forefront in refining cognitive and information processing models of human mental functioning. The new computer programs are throwing light on questions as diverse as human personality, problem solving, perception, language and creativity. For example, Boden (1977), illustrates how AI research into machine vision is contributing to psychological theories of human vision and also making conceptual contact with physiological knowledge about the human visual system.

AI research has triggered a spate of new philosophical enquiry in many fields of philosophy. It is contributing to philosophical controversies in logic, epistemology, language and science. The most dramatic impact appears to be in the philosophy of mind; for example by stimulating new ways of thinking about many traditional problems including the mind-body problem , human subjectivity, freedom, purpose, consciousness and free-will.

The intellectual contribution made by AI resides in its provision of a computer metaphor for the mind. Obviously any attempt to build a system which models human behaviour and thought, forces a close analysis of fundamental questions about mind, existence and the self.

The revival of interest in these fundamental philosophical questions generated by computer science is reflected in many popular books. In particular the books of Hofstadter have had tremendous popular appeal. Readers of books like Gödel, Escher, Bach: An Eternal Golden Braid (Hofstadter, 1979) and The Mind's Eye ( Hofstadter and Dennet, 1981) are taken on intellectual journeys to demonstrate, for example, how hierarchical and self-referencing systems can lead to a notion of self.

Boden contends that AI provides a scientific explanation of, *"how it is possible for psychological beings to be grounded in a material world and yet be properly distinguished from 'mere matter'. "* (Boden, 1977, p.473)

Minsky (1987) uses constructs from machine intelligence to provide explanations of how mind can arise from the working of smaller 'mechanical' components which are themselves mindless. He sees the mind as a 'society' of smaller processes which he called agents. *"Each mental agent by itself can only do some simple thing that needs no mind or thought at all. Yet when we join enough of them we can explain the strangest mysteries of mind"* (Minsky, 1987, p.17).

He develops the argument to explain phenomena such as the self, self-awareness, self-control, personal identity, consciousness, memory, emotions, learning, humour, language, and so forth.

According to this kind of approach we have undervalued what is meant by 'machine' in the past. We have tended to dismiss the notion of human brain as machine because we have had a limited metaphor of machine. The development of machines which have self-modifying and self-referencing processes built into them are forcing us to rethink the position. Until recently the technology and theories did not exist to even begin studying the brain as a machine.

Authors such as Minsky have no doubt that as the technology and the theories develop it will be shown that the brain is a complex machine, but a machine quite unlike any to date. In addition if it ever becomes possible to build machines

which simulate every component process of the human brain, then those machines will think, have self-awareness, a sense of identity, and all those other characteristics we think of as human. We are in effect being told that it is possible to think of mind as 'machine', but in order to do so, we need to radically alter our conception of the nature of machine. In the past we have been able to dismiss the idea because we did not have appropriate machines as models.

In thinking about a computer as a machine, in this sense, it is probably not helpful to have in mind a mechanical device consisting of a collection of on-off electronic switches following a step-by-step program in a rigidly fixed sequence. From the perspective of AI theories it is more appropriate to consider it as a machine constructed of logic. The actual components of the machine are irrelevant so long as they can embody the logical processes.

The steps in the logical process do not follow a rigid and determined sequence as most people may imagine. Many programs have high degrees of flexibility and imprecision built into them. They don't necessarily produce perfect solutions , or even the best possible ones; like humans they are not perfect. Often the components of a program interact in conflicting and competing ways. In many cases the machine is taught how to learn and as it acquires new information, it can make conclusions and perform actions which were not specified at the outset.

The machines with AI have complex hierarchical structures with the ability to modify themselves, they contain things like frames, concept networks and heuristic algorithms, they have interacting components and they are accepted as being unpredictable, incomplete and imperfect. A far cry indeed from earlier conceptions of machine and if some researchers are correct, they contain the

elements from which mind may emerge. Not all people will be convinced by the arguments but they are certainly breaking down the resistance to accepting mind as machine. As Boden concludes: *"The achievements of current machines suffice to make it intuitively less implausible than heretofore that mental phenomena may be grounded in a mechanistic physiological base, namely, the brain"* (1977, p.444).

The rapid progress in AI in the 11 years since then, with developments such as fifth generation computers and parallel processing, has further reduced the implausibility gap. We are being presented with more and more complex images of machine which continue to challenge many of our earlier assumptions about the nature of mechanical processes.

### Influence on intensive users

The impact of new technology is not restricted to theoretical matters in psychology and philosophy, it can also bring about dramatic changes at a personal level. The second nature of a computer has the power to change the way people think about themselves. Computers have the capacity to evoke responses in humans in ways which other non-human things cannot.

For many people who work as computer scientists and programmers the computer acts as a psychological and philosophical machine. The same can be said of children and computer hobbyists who interact intensively with their machines.

The phenomenon is clearly demonstrated in the ethnographic studies of Turkle (1984). Her subjects were people who used computers extensively and she explored differences between age groups and between adult computer subcultures. She found that computers promote strong feelings and provide personal meanings in ways which are more powerful and qualitatively different from other technologies. She also found that there are three general, but non exclusive modes, in which computer users relate to the machines; these she called metaphysics, mastery and identity. To a remarkable extent the different modes are related to an intellectual and emotional developmental sequence in children.

According to case studies, younger computer users use the 'smart' machines as a vehicle for metaphysical enquiry. Is the machine alive? Does it have intentions and feelings?

A smart computer can talk and win at games and have access to many facts while at the same time it has other properties that make it seem not alive. This creates a predicament for the children which they try to resolve. *"In the process it forces them to think about how machine minds and human minds are different and so enters into the development of psychological reasoning"* (Turkle, 1984, p.45). Many of the young children concluded that the essence of being human lies in human emotions and feelings.

From about nine years onwards the metaphysical activity becomes less important and the desire to master the machine takes on significance. The computer becomes a challenge and they must beat it or find ways of making it do what they

want. In a relatively extreme form it is shown in the aggressive and passionate arena of computer arcade games.

With adolescence comes a return to reflection but this time the prime concern is with using the machine to help test and develop ideas of self; this is called the identity mode of relating to computers. In the search for personal identity the computer is used as a mirror for reflecting oneself. Some children use programming at this age to externalize and experiment with personal issues and emotional states. This can take a variety of forms from using the machine to build a safe environment to using it to play out emotional conflicts. One can interact with the machine in an emotionally intense way but remain safe and secure. The machine acts as a mirror by enabling users to see a pieces of themselves reflected back from the machine.

Some adolescent programmers are quite explicit about seeing the computer as reflecting something about their own minds. They begin to use the computational metaphors to talk about their own thinking. Many of Turkle's adolescent subjects used machine analogies to explain their own thinking and the differences between themselves and others. They used terms such as 'machine code', 'high-level language', 'debugging', 'loops' and 'reprogram' to explain their own mental states, their problems, and possible ways of resolving them.

According to Turkle these ideas come naturally from interaction with the computers and not from specific contact with the theories about mind as program. *"The computer is enough like a mind to make analogies between the self and programs seem plausible."* (1984, p.161).

The modes of relating to computers displayed by the children are reflected in the computer subcultures of the adult world. The researchers into artificial intelligence in their role as modern-day philosophers are extending and formalizing the interests of the child philosophers. Likewise it is an obsessive quest for perfect mastery of the machine which characterizes the so-called computer 'hackers'. Similarly many of the home computer hobbyists can be seen to be using the machines to express and explore their personal identities. The three modes of relating to the second nature of computers are of course not exclusive and many users are involved with all three.

What Turkle has shown is that some people are relating to computers in very intimate, complex and differing ways, and that the nature of the interaction for any person depends on the personal characteristics of the individual and the cultural context in which they use the machines.

Another group of people for whom the second nature of computers may be important, is the novelists, who have opportunities to use computers in sophisticated ways; for example, in modes which enable them to have extended discussion with themselves.

**Growing influence of the second nature**

It was suggested earlier that the first nature of computers is already having an impact on many humans and their quality of life in terms of employment, leisure, privacy, and so forth. It's dehumanizing potential was described earlier. A consideration of the concept of the second nature adds to this concern. Now the impact could take on a more personal and deeply rooted character. Less

intelligent machines do not offer the challenge to think about what it means to be human.

As intelligent computer applications become more widespread it can be expected that there will be a rapid increase in the numbers who confront the second nature.

For example, it is already possible to witness a dramatic change in attitude towards the machines when people begin to use adventure game programs for the first time. When a machine is able to interact with a person using complex 'human' logic it begins to evoke responses that were once reserved for other humans.

One can observe people treating the machine as though it had a mind and they ascribe to it such characteristics as intention and purpose. During the interaction with the machine there is a growing sense of trying to 'outwit' it.

The change in attitude is most dramatic among those whose previous experience was limited to the less intelligent uses of computers.

As suggested earlier, the significance of such an interaction with machine intelligence would be determined, to a large extent, by the metaphysical assumptions of the individual (probably unanalyzed) about the nature of machine.

While computer metaphors lead many thinkers to refresh their understanding of what it means to be human, it is certain that not all people will see it this way.

The majority of people know nothing of programming and are unaware of the debates surrounding machines and minds. It is certain that they think of computers as machine in the old sense of machine. It seems likely therefore, that confrontations with intelligent machines could add to the dehumanizing effect of technology. An individual may ask: *" If something completely mechanical can outperform me, then where does that leave me?"*

Most people are not too concerned when a machine can outperform them on tasks which they perceive to be mechanical; performances involving computing speed and power only conform with what they have come to expect of machines. However a machine performance may become disturbing when it encroaches on the intellectual territory they had reserved for themselves.

Personal accounts indicate that many people find the experience disturbing and may begin to suffer a certain undermining of their self-concept. Some people have been disturbed when beaten at chess or continually outwitted in an adventure game by a computer. Future programs that will outperform us on a range of intellectual tasks, make better decisions than we, or even speak our language better than we, will not help alleviate the feeling. Many people may experience the new machines as undermining aspects of the way they see themselves as human beings.

There is a real danger that the coming technology could increase the feeling for many of being just a cog a machine. A loss of a sense of worth and purpose could lead to personality problems with significant social consequences.

Many of the AI researchers feel that such problems could be avoided by promoting the humanizing potential of machine intelligence. For example Boden concludes:*"If this commonly unsuspected 'humanizing' feature of artificial intelligence can be brought home to the general public, then many of the ill effects I have so far hypothesized in this section will be allayed"* (1977, p.460).

Part of the task would be to inform people about the changed nature of machines; presumably if they come to see the machines in the same way as the researchers see them, then they should no longer feel undermined by them.

As before, the task will largely fall to the education sector to bring about a change in perception. We must find a means for ensuring that citizens come to perceive the coming generation of intelligent machines as humanizing agents. This may prove to be as difficult a task as the building of the machines in the first place.

## SECTION 3. THE PERCEPTIONS AND ATTITUDES OF AUSTRALIANS TOWARDS NEW TECHNOLOGY

The first section included speculations about the possible impact of technological developments on human beings in terms of their needs, aspirations, self-perception, sense of self-worth and so forth. In this section attention focuses on the actual perceptions, beliefs and attitudes of Australians towards technology and its impact on society

Unfortunately the data available are restricted in size and scope, but it is possible, nevertheless, to draw some conclusions from the limited information at hand.

**Ambivalent responses**

In general it would seem that Australians have ambivalent attitudes towards Science and Technology. There is evidence of conflict between the rational and emotional responses of many Australians.

The Mackay Report (1986) concluded that, *"The rational side of Australians acknowledges that the technological revolution is inevitable and that it is all 'part of progress'. Emotionally, however, the rate at which changes are occurring produces fear and resistance"*. Similarly, Eckersley (1987), in a review of the available literature summarized the position,
*"Information from recent surveys shows that we generally regard science and technology as a good thing, but feel threatened by their growing and seemingly uncontrolled power"*

The data indicate that many Australians fear that technological progress may be heading in directions which could suppress human creativity and work against human interests. For many citizens the feelings of resistance to computers and new technologies are deeply felt and mostly negative.

**Technology and the future**

The negative feelings are at their strongest when citizens are asked to consider the future. The majority of adults studied felt that a significant war was

inevitable and that computer based technology would only contribute to the horror. They also felt that the spread of technology would increase economic inequities in the community and increase feelings of personal alienation and diminish personal autonomy of the individual.

Surveys among young people about the future reveal even greater disquiet and fear. A study by Digby (1985) among children 10 to 12 years old, indicated a general pessimism with science and technology being seen as a threat. In spontaneous responses the children frequently mentioned nuclear war, pollution and job shortages as consequences of technological change. Many were convinced that the greatest threat was a "take over" by robots. Typical responses were of the following kind.

*"When I grow up I think the world would change very much. There will be more inventions and more things we could use instead of our hands . The world would be different because I think computers and robots will take over the world"*

*"More unemployment because robots will take over jobs"*

*"There will be many computers and we will be taken over by them. The computers will overtake us."*

Overall, about half of the sample were pessimistic about the future with 40% seeing the world as being threatened. The proportions of those with negative impressions increased with age. About 40% of the children who felt powerless in the face of change saw it as taking away their ability to determine their own futures.

Studies by Wilson (1985), in which children aged 14 to 17 years were asked to openly express their fantasies about the future in 20 years time, gave a similar picture. For many the scenarios were filled with feelings of fear and alienation. Again the pessimism increases with age.

According to Wilson *"The young people no longer believe that greater technology means greater human progress. Yet they cannot conceive of progress without more technology."*

One child wrote, *"The nuclear holocaust has come and gone. Technological civilization has survived. But the myth of goodness isn't there"* (Eckersley, 1987, p.19)

**Changes over time**

There is some evidence of increasing support over time for developments in science in technology. Eckersley (1988) reports the results of a comparison between responses of identical items in 1983 and 1987. The respondents were asked to rate technological progress in respect of advantages and disadvantages. The surveys indicate an overall increase in support, over the four year period, with marked differences between groups depending on occupation, education, income and sex. For the total sample the approval rate increased from 54.3% to 63.5%. In general women are less favourably disposed to technology than men. People who have better education, are in the professions or who are more highly paid tend to have more positive attitudes than those at the other end of the scales. It may be that the latter groups feel more threatened in their work, are more likely to regard themselves as 'victims' and are less likely to be able to buy into the technology and hence feel less comfortable with it.



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**The economic potential of technology**

In recent years there has been a great deal of public discussion about the importance of science and technology in the context of industrial competitiveness and economic growth. One can expect that those with high socio-economic status and working in positions of decision making and power are more likely to see the economic potential of technological developments and feel less personally threatened by the spread of technological applications. The comparative survey indicated that the gap in approval rate between the 'haves' and 'have-nots' in Australian society is widening. For example, the 1987 approval rate for the professional group reached 89.5% while for unskilled and semi-skilled it was only 54.5%.

**Technology and unemployment**

Currently in Australia, many citizens are critically concerned about environmental issues, high interest rates for home mortgages, rising prices for food, and increased unemployment. The latter frequently tops the list of Australian's concerns but it is not seen to be very closely related to technological change and the impacts of computers, robotics and automation. The Changing Australian Survey (Social Science Data Archives, 1983) study indicated that only 15% of leaders and 11% of the workforce nominated technological progress as the main cause of Australia s continuing high levels of unemployment. Even fewer proportions of the two groups, 9% and 13% respectively, saw a slow-down in computer use and automation as a priority for reducing unemployment. The increasing use of machines to do jobs that people once did, seems to be seen as an inevitable consequence of progress and less important in determining

employment than other factors such as incentives for investment and economic recessions. It could be suggested that changes in this country are not as extensive as in other developed countries and therefore fewer individuals have been directly replaced by a machines.

**Relationship between attitude and experience**

In the first section it was suggested that close personal contact with computers can bring about a dramatic change in attitude towards technology.

The Mackay Report (1986) found that each of their discussion groups included those who had used computers and had experienced a 'conversion' and were now optimistic about a technological future. The data is too limited to draw any general conclusions but it is consistent with informal observations when, for example, a skeptical friend or colleague discovers the power of a computer to improve their work; an academic with word-processing; a person in a small business with a spreadsheet; a mathematics teacher with software for algebraic manipulation; and so on.

## SECTION 4. CHOICES FACING HUMANITY IN THE USE OF TECHNOLOGY

Before introducing the role of education into our treatment it may be useful to summarize some of the choices that face humanity and some of the issues related to the decision making.

**Extremes of choice**

So far this review has shown the widespread impact that technology is having upon all aspects of society. It was shown how computers, seen as machines for processing information, have profound implications for an economy. They also give rise to many concerns in the face of human needs and aspirations. They provide opportunities for human machine / interactions which are unlike any in the past, and which may even alter the way humans see themselves.

The technological developments offer extremes in possible alternatives; on the one hand they could be used to enhance the adaptability, freedom, responsibility and personal competence of citizens; on the other hand they could be used by the powerful and rich to increase control and domination over citizens. The new technologies can certainly generate wealth but it need not be shared among all citizens. We have seen how the technologies have the potential either to alienate and dehumanize us or to help us renew our humanity. At each point we are faced with decisions.

**Alternative futures**

In the face of the possibilities an optimist must make the assumption that future paths are not inevitable and that it is possible to make wise decisions when appropriate information is available. The setting up of the Commission for the Future by the Commonwealth Government of Australia, in 1985, was an exercise of optimism; it being assumed that it is possible to describe the kinds of futures that one might desire.

In part, the Commission's function is to explain the social impacts of science and technology and to report this to the Australian Government. Also in part the Commission's function is to give to human beings the capacity to shape the social impacts of science and technology. In 1989 the Commission began five projects concerned with mapping out desirable futures for the country under the headings Sustainable Futures, Creative Futures, Enterprising Futures, Healthy Futures and Australian-Japan Futures. This activity is a significant example of an attempt to ensure that decisions are made about technological use which acknowledge their impact on individual human beings

**Extent of trust in decision makers**

It can of course happen that an individual can be unexpectedly delighted with some technological applications but at the same time feel despondent about a technological future when viewed from a wider perspective. One could feel grateful and happy with developments on a personal scale but feel that decision makers, particularly in the political field, were failing to give good direction to ensure that other developments in technology would be used to improve the quality of human life. It is one thing to be happy with one's personal computer at home and all the things that can be done with it, it is another matter to feel comfortable with technological applications such as 'star-wars' defence, the establishment of nation-wide citizen data bases, the spread of robots on production lines, and so on. Such speculation may help explain the widespread ambivalence about technology.

As individuals many of us see technological progress as welcome and probably inevitable, but nevertheless feel a deep unease about some applications and some

general directions. To some extent we feel like victims. We appreciate some immediate possibilities but feel suspicious that others may not operate in the human interest in the long term. The level of unease may depend on the extent to which we really trust our political and industrial leaders.

Australians, for example, have a reputation for a certain healthy skepticism towards those in authority. As a consequence when authorities suggest that a particular development would be in the best interests of all citizens they are often not believed. It may be, therefore, that Australians feel comfortable with technological developments to the extent which they both understand the technology and feel able to contribute to the decision making about the use of the technology.

Perhaps it is the case, in all societies, that the extent to which individuals feel powerless in the face of technological advances is directly proportional to the extent which they feel powerless in the face of any decision making in their society.

Almost paradoxically the technology itself opens up possibilities for increased participation by individuals in specific collective decisions. For example, frequent referenda could be carried out via electronic means from the home. The degree to which technology is used to increase the autonomy of individuals will of course depend on the decisions made by those in authority.

**Informed debate the basis for making choices**

In the face of the extreme possibilities opened up by technology the citizens of free societies will need, somehow, to exercise a collective right to choose an appropriate path. The basis for decision making is informed debate, not only about the technology, but also about the potential impact it may have on human beings. This point is given emphasis in the recent Science and Technology Statement in Australia (Hawke & Jones, 1989).

If there is to be informed public debate about the alternatives then education has a critical role to play in ensuring that as many citizens as possible are informed about the technology and its possible impacts. It is important therefore to consider how our education systems can best meet this challenge. The technical and vocational (T&V) sector is critical as it produces a large proportion of those who will be expected to be leaders in technological fields. If a society is to use technology in humanizing ways it is vital that all T&V students are confronted with the relevant information and are required to consider the use of technology from a human perspective.

## SECTION 5. TECHNICAL AND VOCATIONAL EDUCATION IN AUSTRALIA

### General and Vocational Education

As in other countries, the links between vocational and general education are numerous and complex. In one sense, the first ten years of education can be described as general, since there is very little specific vocational preparation but

there is an increasing emphasis in the latter part of this period on the links between education and work: this includes an increasing number of options which include technologically based subjects; the introduction of work experience, and, more attention in all subjects to the implications of the study for vocations.

Year 10 was, of course, the period when many Australian students left school to go into employment. In recent years, largely owing to the drastic reduction in full-time employment opportunities for young people, the trend to continue into Year 11 of secondary education or into an aspect of Technical and Further Education (TAFE) has grown and will continue to grow. The Government expectation is that 65 percent of the age-group will continue until the end of Year 12, and this policy is already in sight of its full implementation. At the same time there has been a significant increase in the numbers going into TAFE, both post-Year 10 and post-Year 12. TAFE thus offers courses parallel in time to the later secondary years and also to the early higher education years. In Years 11 and 12 of the secondary schools, there is now a greater emphasis on the vocational purposes of education. It is also true to say that TAFE is showing a greater concern for general education, since courses that are too narrowly skill-based are of little long-term value in a society where technological change is so rapid.

University education likewise has a complex mixture of vocational and general education. The Arts degree is usually thought of as a generalist degree, yet its graduates use it as a basis for their vocational choices. Engineering and law degrees are, on the other hand, typical of specifically vocational preparations. Yet even here, many engineers and lawyers go into employment which does not make direct use of their degrees.

Thus, it is not possible to describe any of the sectors of education, primary and secondary, technical and further, university, as being exclusively general or exclusively vocational. Recent changes in technology and consequent changes in work structure, calling for multi-skilling, will make the divisions between these emphases, even more permeable.

These changes have had and will continue to have particular impact on the Technical and Further Education sector. TAFE providers have become more sensitive to industrial and commercial requirements but are also aware of the danger in becoming linked too closely to the current situation and to day-to-day problems when it is also necessary to take a longer view. TAFE recognises the need to take account of technological change, since it will affect the demand for old skills and produce requirements for new skills. TAFE also plays an important part in providing for the recurrent education of members of the workforce whose skills cease to be in demand or require up-dating. There will continue to be a tension between the short-term demands on TAFE to provide for the immediate situation and the long-term demands which require the capacity to adapt and change. The current moves in Australia towards industry restructuring make the task of TAFE, and of other educational providers, even more important. This involves the substantial changing of work structures across an industry through changes to industrial awards and also changes to informal agreements, permitting new work practices and new approaches to work organisation.

**Skills shortage in Information Technology for Industry**

There is a perceived shortage in Australia of people with skills in the information technology (IT) industry. This is due to a number of factors. The most obvious, of course, is the very rapid growth in demand, in contrast to many other areas of the workforce where there is a substantially reduced demand for labour. A further problem is that tertiary institutions are having difficulty in responding with sufficient speed: the courses which do exist, often can provide only a limited number of places and the curricula often lag behind the technological changes with which they are dealing. This latter aspect is a particular problem with respect to hardware, which becomes out of date much too quickly to permit replacement in the normal institutional pattern of up-dating equipment.

In spite of the difficulties, Australia has developed a good reputation in training for IT. The rapid growth of IT in the schools and its pervasive and growing use in the general society have contributed to the formal mechanisms for preparation so that the problems have been made more difficult but have not presented significant growth and development. A major element in the development has been the achievement of cooperative arrangements between educational institutions, government and industry. For example, at Sydney Technical College, a tripartite venture of the college with the State and Federal Governments has introduced the Computer-Integrated Manufacturing Techniques Training Centre (CIMTTC) to provide both TAFE and industry with the knowledge and expertise needed to develop the very latest in technology. The Centre has been established at a cost of $1.5 million to allow further developments in training in the important field of computer-integrated

manufacturing. The linking of simulation approaches and robotics to a sophisticated micro-computer provision, provides a necessary impetus to current courses in the area and an opportunity to develop quite new approaches. Likewise, the Queensland Mt. Gravatt TAFE College has received support from Prime Computers of Australia, the State Government and the Federal Government to increase its capacity in computer-aided design and computer-aided manufacturing. This enables the college not only to update its own programs but to become a consultancy resource to industry, government and other educational users. The links include the aircraft industry and the fashion industry and gives the college a substantial base of expertise in the use of robots.

In spite of these substantial and encouraging developments, a survey by the Information Industries Education and Training Foundation estimated that while the industry currently employs 215,000 skilled workers, there is a current shortage of 45,000 which would grow to a shortage of 80,000 in two years time. (Information Industries Education and Training Foundation Survey, June 1989). The following points were made.

*"In Schools, excellence in mathematics is erroneously regarded as a prerequisite to a computer industry career and there are no specifically technology-oriented teachers to say otherwise;*
*Academic institutions, government and business often use different, and in some cases misleading, job classifications;*
*Many Australian graduates are lured overseas, while foreign students in Australian colleges and universities are obliged to return home when they graduate; and*

*The Federal Government has increased the number of technology-oriented tertiary places but there are neither the funds nor the teachers available for a complete solution.*

*Industry is unwilling, and has little incentive, to fund graduate courses. And where businesses hold in-house training courses, the qualifications are not officially recognised.*

*'It is clear that existing mechanisms are not addressing the problems and it is also clear that Australia is lagging behind other countries in solving these problems,' Mr Wroe said.*

*'We are going to be looking at a fundamental imbalance for some time.'*

*'DEET(Department of Employment, Education and Training) realises that there are shortages and has funded an extra 900 tertiary places this year, industry is funding another 200. But when you are dealing with a shortage of about 26,000 people you quickly realise that there is a long way to go.'*

*Australia has about 33,000 computer scientists with another 200 graduating each year and 4000 electronics engineers and 500 graduating a year.*

*The Department of Industry Technology and Commerce (DITAC) has said Australia must at least double its stock of computer scientists and electronic engineers before the year 2000.."*

The problem is substantial. It is encouraging to see the signs emerging of the major cooperation between industry, government and the education sector. Only through such cooperation on an extended scale can the problems be solved.

**Development of technological schools**

In recent times all secondary education in Australia has been carried out in comprehensive high schools (years 7-10 or years 7-12, in most states) and in some general purpose secondary colleges (years 11 and 12). The recognition of the impact of technology and the need for closer links between education and work has led to the creation of a range of alternative schools with a technological emphasis. Some examples of these enterprises are presented below.

**South Australia School of the Future**

This is an initiative which is financed by the state government of South Australia with a grant of $A250,000. Computer equipment for the school is being supplied by a Queensland based company, Computer Corp. of Australia (CCA). The company supplies Cleveland machines to support the teaching of subjects such as computer aided design (CAD), computer aided manufacture and computer numeric controlled machining. The mode of operation of the School of the Future is described in the words of the school manager.

*"As many as 150 students per week will be able to work intensively over two or three days"* (Richardson, 1989).

**Technology schools in New South Wales (NSW)**

The state of NSW is in the process of designing a series of technology high schools having close links with local industries. A pilot scheme is to be based on

a current project involving a girls high school, a boys high school and the aircraft manufacturer Hawker de Havilland. All of the schools under consideration are to be situated near existing TAFE colleges and will be expected to form complementary relationships with them. Local businesses and industries will play an important role in the schools which will include development of courses and exchanges between teachers and employees in the companies.

**Altona high school project**

Prime Computers of Australia and the state government of Victoria have jointly funded a pilot project at Altona High School situated in a highly industrialized suburb of Melbourne. The equipment and software will enable communication between local schools, the regional office and access to the databases of surrounding industries. The project is part of a government plan to ensure that school computer training is made more relevant to the needs of business.

**Claremont Education Park**

In Tasmania the Claremont Education Park will open in 1990 and provide senior secondary students with courses designed to help them acquire the knowledge and skills to participate in a society increasingly dependent on innovative, skilled and enterprising individuals to develop wealth.

It is not intended as a return to a technical school of the past with a somewhat narrow trade training emphasis, rather the concern is to give students both a general academic background and technological and technical training. Emphasis is placed on the development of student capacities such as skills in communication, problem solving abilities, knowledge of work and technological literacy. In addition the aim is to promote and develop the students qualities of

innovation, initiative and enterprise. It is hoped that a combination of traditional academic subjects and the new courses will produce students with capabilities that would be attractive to entrepreneurs and workers in a technologically sophisticated society. In addition it is thought that the approach will increase the chances of success for those who wish to pursue further study after leaving school. The approach is in line with the 'skills passports' concept promoted by the OECD (Ball, 1989)

There are plans for the courses to be provided by four integrated centres of learning within the institution, the Centre for Technology and Applied Science, the Centre for Communication and Graphic Arts, the Centre for Business and Enterprise and the Centre for Asian and Australian Studies. In addition there will be a subject called 'Learning Enterprise' drawing on each of the centres and involving practical workshops and involvement in projects and enterprise activities.

As with the initiatives in other places in Australia, great emphasis is placed on links with industry and co-operation with other agencies and institutions. In particular plans are underway for a cooperative venture with Technopark (Tasmania's technology park).

Each of these initiatives provides further evidence of the desire to form cooperative arrangements between education, government and industry. They highlight the prevailing thinking which dictates that technological education must become more closely linked to the economic development of local communities and to the generation of wealth in the country as a whole.



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**Courses on the social implications of technology**

It appears that very few TAFE colleges include a component of social implications in any of their courses. Hall (1988) reports that in a survey of the 245 TAFE colleges in Australia only 11 indicated that they have any course which includes a relevant component. The reliability of the information was supported by follow-up investigation.

The Hobart Technical College in the State of Tasmania is one institution that is making an effort to include an investigation of the social implications of technology for some of its students. Students studying for the Associate Diploma of Computing in Science and the Associate Diploma of Computing in Business have the opportunity to study a subject with the title 'Computers and Society'. Currently it is offered as a common optional subject for both groups of students; it is one of seven subjects from which the students must choose six for study. Currently about 50% of the available students choose this option.

It is the only course of its type offered by the institution. There is no evidence that students in other technical and vocational courses are systematically considering the issues concerning the appropriate use of technology.

The subject Computers and Society lasts for sixteen weeks with three hours of class contact each week. The topics covered include :
Computer Developments: Past, Present and Future
Computers in Industry: Employment Implications
Computers in Health, Education and Science

Databanks and Personal Privacy
Security and Computer Crime
Computers in Commerce
Military Implications
The Computer Industry
Appropriate Responses to Industry- "Luddite" vs "technological determinist" vs "guided technology" approaches.

For each area there is a set of questions guiding the students to find suitable information and to discuss the implications for individuals and society in general. Each student must choose one topic for a major assignment and a second topic from a different area for a tutorial presentation and paper. No attempt is made by the teachers to present a committed position on any topic. The students arrive at their own conclusions following their reading, the input by the teacher and class discussion. The range of possible conclusions is illustrated, for example, in the following excerpts from student work.on the topic concerning military implications.

*" The case for AI in weapon systems is very strong, as more and more research, money is poured into this field, the advantages of not having human instinct, means a greater degree in confidence in the decision making process and timing of the highest order".*

*" The Star Wars project is doomed to fail. The idea of a perfect defense in itself has seen to its failure".*

*"The other point is in human judgement where morality, ethics and conduct might delay vital and critical decisions".*

*"The reliability of of all working components in the program cannot be guaranteed".*

These excerpts clearly reflect student perceptions about the use of technology in society.

To date no systematic attempt has been made to evaluate the overall impact of such a course on the perceptions and beliefs of the students. In the second half of 1989 a questionnaire is to be given to a new group of students, before and after the course, in order to see if changes occur.

A set of suggested student performance objectives for such courses is provided in Annex 1.

## SECTION 6. THE IMPACT OF TECHNOLOGY COURSES ON STUDENTS IN T&V EDUCATION IN AUSTRALIA

### Lack of research data

While there were limited data available about Australians in general (reported earlier) no information could be found concerning the impact of technology courses on the perceptions, beliefs, attitudes and personalities of students in the T&V sector.

**Recommendations for future studies**

This deficiency needs to be corrected if recommendations for action are to be made with any conviction. A series of studies is needed to establish a framework of information concerning the Australian student body.

The analysis of the impact of technology on the human spirit, carried out in the second section of this paper, makes it possible to suggest the form and content of appropriate research. A widely based survey of the student body is needed to seek opinions and beliefs on several topics. An investigation should seek to obtain responses from TAFE students on the following topics.

-Their level of confidence in the decision makers to ensure that technological applications are used to improve the quality of life for citizens.
-The extent to which they think that ordinary citizens can have an impact on how technology will be used in the country.
-An overall judgement about where the balance lies between the advantages and disadvantages due to technological development. Separate responses for the present and the future, in 20 years or so from now.
-The extent to which they think that, overall, the advance of computer technologies have a humanizing influence on individuals. Separate responses in relation to the present and the position in 20 years or so from now.
-In the coming decades do they believe that humans can and will keep control of the machines they build.?
-Do they think that their chosen career could be threatened by technological developments. Separate responses for the short and long term.?

-In what way do they think the next generation will be different from this one due to advances in technology? Separate responses for items such as 'work' ( in terms of satisfaction and time). 'Leisure' (in terms of enjoyment and time). 'human happiness', 'living fulfilled lives', 'living creative lives', 'financial prosperity', 'cultural participation', 'complexity of life', and 'social equality'.

-In the coming decades how do they think advances in computer based technology will affect people as individual humans? Separate responses for 'reduced feelings of being in charge of own lives', 'reduced confidence in our own decisions, 'reduced interaction between people', 'increased power of those in authority over the citizens', 'feeling less free in society-increased feelings of insecurity', 'reduction of level of personal privacy', 'increased access to a range of information'.

-Beliefs about the possibility and desirability of building machines which can outperform human beings on intellectual tasks and have feelings and self-awareness attributed to them. Include their comments about how such possibilities may affect the way humans feel about themselves as human beings.

-The extent to which they use computer models or computer technology to describe their own thinking or the thinking of others.

-How their work with computers may have affected their relationships with other human beings.

-Whether working with a computer has satisfied some of their emotional needs.

-If they think that working with computers has affected their personality in any way. Less friendly to others, more easily annoyed, more aggressive, more confident, and so forth.

-If any uses of technology have made them feel less human. Like a cog in a machine or a barcode instead of a person, etc.

Responses to this range of topics could be obtained by administration of a suitable questionnaire. More detailed and supportive information would require individual interview techniques.

**Range of research questions**

The patterns of responses to the items could be related to such background variables as the course of study, the number of years of study, sex, age and the extent of experience with computers. In particular, it would be of interest to make comparisons among those students who study courses in which technology is content, those who learn how to use the technology, those studying computer literacy courses and so forth.

The information would make it possible to determine how widespread the human/machine interaction patterns, revealed by Turkle's ethnographic studies, are among the students who study computer science and work intensively with the machines.

The most critical information for those concerned that students become committed to using technology in humane ways is that from students who study courses specifically concerned with the social impact of technology. A comparison of student responses 'before and after' would reveal if students tend to shift their approach towards or away from a 'humanizing' stance as a result of studying such courses.

A study of this kind is being carried out in the second half of 1989 with students studying the course on the social implications of technological change at the Hobart Technical College (described earlier).

This paper would recommend that similar studies be given a high priority in order to give a more accurate picture of student perceptions of technology in the context of human values and culture. The lack of hard data makes it difficult to do more than express opinions about the present position and what might be done to improve it.

## SECTION 7 THE CONTRIBUTION OF T&V EDUCATION TO PROMOTE THE USE OF TECHNOLOGY IN A HUMANISTIC SPIRIT.

The situation we have been describing is profoundly different from anything we could have predicted even sixty years ago. Then the situation was relatively straightforward : the universal stage of education was in the primary schools. This was followed by an academic secondary education for a selected few and, possibly, a parallel technical education, also for a few. The best secondary students were selected out, to continue on to universities, whose purpose was to extend knowledge through research and reflection. The pace of change, in knowledge and in society, was deliberate and made little impact on education. True education was seen as dealing with 'theory' while the 'world of work' was the domain of practice. Academic education could conceive itself as quite separate from these practical concerns.

The growing pace of technological change and the social upheaval which has resulted, have broken down this separation. This has been exhibited through two phenomena : the first is the startling growth and the diversification of knowledge; the second is the dramatic change in the structure and nature of work which has followed from the technological changes linked to the developments in knowledge. So far these changes have happened, rather than being shaped. If these technological changes have wrought a revolution, as it is often described, it has been an accidental revolution yet more profound and disturbing than the achievements of the ideological revolutionaries. The future, for Mankind, will depend on the extent to which we can shape and direct technological change, to peaceful and beneficial purposes.

The need for specific courses on social implications

The vital importance of the need to understand the nature of change, implies that we should build into all technological courses, specific components which consider the social implications of the issues. Hall (1988) argues that people will only be able to influence decisions if they develop an understanding of technological developments and their possible social implications. Currently, the emphasis on such courses is on the acquisition of knowledge and skills, and very little to how, technology may change society and how it may affect us as individuals. Yet we can no longer afford to ignore the moral, personal and social issues which are inevitably associated with technological change, e.g. in business courses, students who learn how to use data-bases to gain information about individuals, should also have to consider the moral question about privacy.

**The need for a balanced view**

One of the difficulties which come with the consideration of social implications, is the likelihood of simplistic treatment, or the presentation of extremes as being an accurate assessment. At one extreme, lie the courses which, by ignoring social impacts, claim implicitly that *"all technological change is good."* At the other extreme is the over-sentimental assessment *"factories are bad because they pollute the environment."* If we are to move beyond these black-and-white pictures, we must develop curriculum materials which explore carefully and sensitively the full implications of technological changes, and not merely the technical aspects.

If this development of materials is to occur, there will need to be close cooperation between educators on the one hand, and scientists, technologists and industrialists on the other. This is important in defining curriculum content : it is even more important in having available the most up-to-date equipment and facilities, and in developing appropriate methods of teaching-learning. The cooperation we have described earlier, between technical institutes and industry, is the prototype of the sorts of links we so desperately need.

Curriculum for a technological society

The curriculum of schools is the expression of what society values most and has selected for transmission to each new generation. In a period of relatively slow change this is a relatively simple process, as the selection can occur over a period with gradual refinement. As the pace of change increases, the curriculum problem changes in two ways. The field of knowledge enlarges to such a degree

that selection becomes a more difficult task. Even more important, as change occurs much of what we "know" becomes obsolete or invalid. Thus, not only is it not possible to master the field of knowledge completely, at a particular point in time but even if that were done, it would rapidly need revision or replacement. Thus, the development of a curriculum for our modern society, is not the search for a correct solution, but the search to develop a process that continually adapts itself, to cope with knowledge changes, to cope with new possibilities in communication, to cope with developing personal and social needs.

Our new concept of a curriculum for a technological society can not be based solely on a selection of current knowledge. As we have already commented, that is subject to continuing change. Neither can it be based on our predictions of what will happen. The pattern of technological change is unpredictable : the plane, the automobile, the micro-chip - these are all developments, whose effects were not and could not have been predicted beforehand. What becomes important is the capacity to learn, to achieve access to new information, to be able to evaluate information, to use it in new ways, to communicate.

Greater capacity for change in educational systems

The problem of curriculum change is related to the broader question of change in educational systems. Our systems are slow to recognise the need for change and cumbersome in its implementation. The pattern of organisation which suited the era of gradual change is no longer suited to our needs for continuing substantial change. To do this, we need more flexible patterns of organisation

which provide for continuing professional development for its teachers and trainers.

We need also to make use of the formidable capacity of the new technology itself, to assist in teaching and learning in technical and vocational education. The problems of memorising or storing vast amounts of information are solved naturally by the NIT; access becomes straight-forward, as does the problem of revising or removing out-of-date information. Unless we use the enormous capacities of NIT we have no hope of coping with the curriculum problems which rise from its existence.

Democratisation of education

The technical problems of the new curriculum, important as they are, are not the most important aspects. It is the human problems which arise, which pose the most difficult questions. Primary among these is the need not merely to maintain the democratisation of education, but to increase it. Yet we are in danger of producing a professional elite, based on access to and mastery of the new technologies. If this occurs, it could leave a "new under-class" which might be permitted to enjoy some of the products of technology, but would have no real say in its use.

To avoid a damaging and permanent dichotomy in our society, we need to be committed to a general education for all, which links studies of science and technology to a broad consideration of human culture and society. On this base of general education, we can develop the continuing patterns of vocational education which will enable people to adapt to new possibilities and new needs.

A vital aspect of our capacity to adapt to a more humane approach to technology will be in the initial education and, even more importantly, in the continuing development of teachers. We have recognised that the initial preparation of teachers is insufficient to prepare them for a career of 40 years of teaching. Yet, we have not seriously faced the enormous task involved in helping teachers to adjust to the problems set by changing technologies. At the moment, we do not even have an adequate supply of people capable of assisting in this task.

**Promotion of technology as a human choice**

We are in danger of mis-interpreting the very nature of technological change. We think of it as something that happens to us, as an independent force, and a threat to our humanity. Yet technology is a human creation, and its use is the subject of human choice. In prospect, technology is a means of increasing human choice and not limiting it. If it increases choice only for a few, and leaves the rest as recipients of charity, its gifts will be harmful. If, on the other hand, we can find means to ensure that ordinary citizens are able to make those choices, then democracy will take on a new vitality. The education sector can play a major role in this process by ensuring an adequate knowledge base for all its citizens, and not only a knowledge base but a social and personal awareness and sensitivity.

We have mentioned before the Commission for the Future. It has as one of its purposes, to demonstrate to ordinary citizens that they need not be powerless in the face of developments in technology. This must be one of the fundamental educational tasks in our world society : to recognise that the future need not be something that happens to us, but something we can help to shape.



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**ANNEX 1**

STUDENT PERFORMANCE OBJECTIVES

Upon completion of this subject, each student should be able to:-

TOPIC 1 - Computer Developments: Past, Present and Future

1.1 Summarise the development that has occurred in computer technology over the last four decades

1.2 Compare the cost, size, reliability, speed-and memory capacity of present-day machines with that of the early machines.

1.3 Explain how this development has resulted in an enormous expansion in the range of computer applications to the stage now reached where computers are important in practically all areas of human activity.

1.4 Discuss the efforts now being made to develop "fifth generation" computers and estimate the impact that such powerful systems would have on our society at large.

TOPIC 2 - Computers in Industry: Employment Implications

2.1 Outline the impacy that computer-aided-design and computer-aided manufacture are having on modern manufacturing techniques.

2.2 Describe the basic dilemma faced by industries world-wide; reduce labour costs by introducing high technology or become uncompetitive and lose markets.

2.3 Explain the essential role that product innovation, appropriate marketing policies and a flexible distribution of labour can have in resolving this dilemma.

2.4 Compare the performance of Australian industries, in this regard, with those of our major trading partners and identify steps that can be taken to improve our international competitive position.

TOPIC 3 - Computers in Health, Education and Science

3.1 Identify the most significant contributions that computer technology has made to the quality of health care, including :

- medical scanners
- ICU monitoring systems
- hospital management
- drug research
- computer-assisted-diagnosis

3.2 Weigh this against the impact that such developments have had on the overall cost of health care and the problems associated with the capacity to prolong life beyond reasonable limits.

3.3 Outline the role that computers are playing in the modern classroom and compare currently held philosophies on how to use computers in education most effectively.

3.4 Outline the major benefits provided by the use of computer technology in scientific fields, for example: - - improvements in weather forecasting

- better communications
- development of new energy sources
- more accurate environmental monitoring

TOPIC 4 - Databanks and Personal Privacy

4 1 Explain the advantages and disadvantages involved in maintaining personal information files on computer systems.

4.2 Identify the dangers inherent in the transfer of such information between computer systems via national and international networks.

4.3 Outline some legislative measures which may be employed to minimise these dangers.

TOPIC 5 - Security and Computer Crime

5.1 Outline the measures which are taken to ensure the security of sensitive programs and data on large multi-user systems.

5.2 Describe some of the techniques that have been used by computer criminals to circumvent these security measures.

5.3 Discuss some of the inadequacies, inherent in our present legal system, which have rendered it difficult to identify and prosecute computer criminals.

5.4 Estimate the danger posed to society by the increasing computer expertise available to organised crime syndicates and suggest measures that should be taken to deal with this trend.

TOPIC 6 - Computers in Commerce

6.1 Describe the basic components which make up an integrated office automation system: word processing, database management and data, voice, text and graphics transmission.

6.2 Identify the difficulties which have accompanied the introduction of office automation systems and outline precautions which need to be taken to alleviate these problems.

6.3 Discuss the changes in company organisation which have been made necessary by the decentralisation of computer facilities within large corporations, away from central data processing departments towards distributed "end-user" computing.

TOPIC 7 - Military Implications

7.1 Describe the "smart" weapons that are now available to the military and discuss the impact of such weapons on the conduct of warfare.

7.2 Outline the basic philosophy of the U.S. Strategic Defence Initiative and briefly summarise the arguments being put forward by supporters and opponents of this program, with particular reference to the feasibility of producing the enormous software systems required.

7.3 Describe the current Strategic Computing program, in which artificial intelligence techniques will be used in U.S. weapons systems, outlining the reasons why it is considered necessary as well as the dangers inherent in such a program.

TOPIC 8 - The Computer Industry

8.1 Briefly describe the structure of the world-wide computer industry and identify the major contributions made by USA, Japan, Europe and the emerging South-East Asian countries.

8.2 Compare the contributions made by Australia and suggest measures we could take to increase our participation.

8.3 Identify the major career paths within the industry and within other associated industry areas.

8.4 Identify the educational requirements for entry into these careers and survey the range of tertiary-level computing courses now available.

TOPIC 9 - Appropriate Responses to Technology

9.1 Compare the three different responses that have been adopted to the introduction of computer technology:

- the "Luddite" response
- the "technological determinist" response
- the "guided technology" response.

9.2 Outline measures we can take as individuals, as organisations or as nations, to assist in promoting the appropriate use of computer technology.

9.3 Discuss the role that professional bodies, such as Australian Computer Society, can play in ensuring that computer technology works for the benefit of society at large.

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